June 29, 1965 J. C. HEVENOR 3,192,448

KEYLESS ELECTRIC LOCK

Filed Feb. 6, 1961 2 Sheets-Sheet 1

Fig. 1.

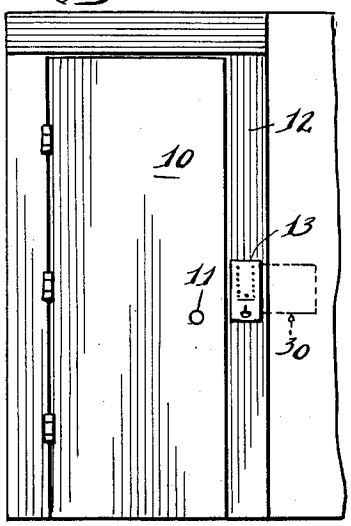


Fig. 2.

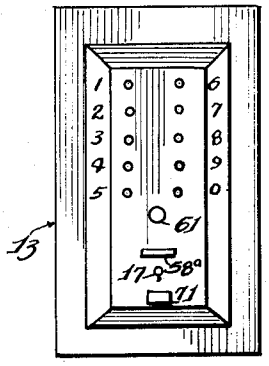
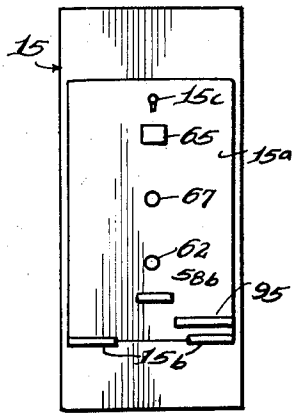


Fig. 3.



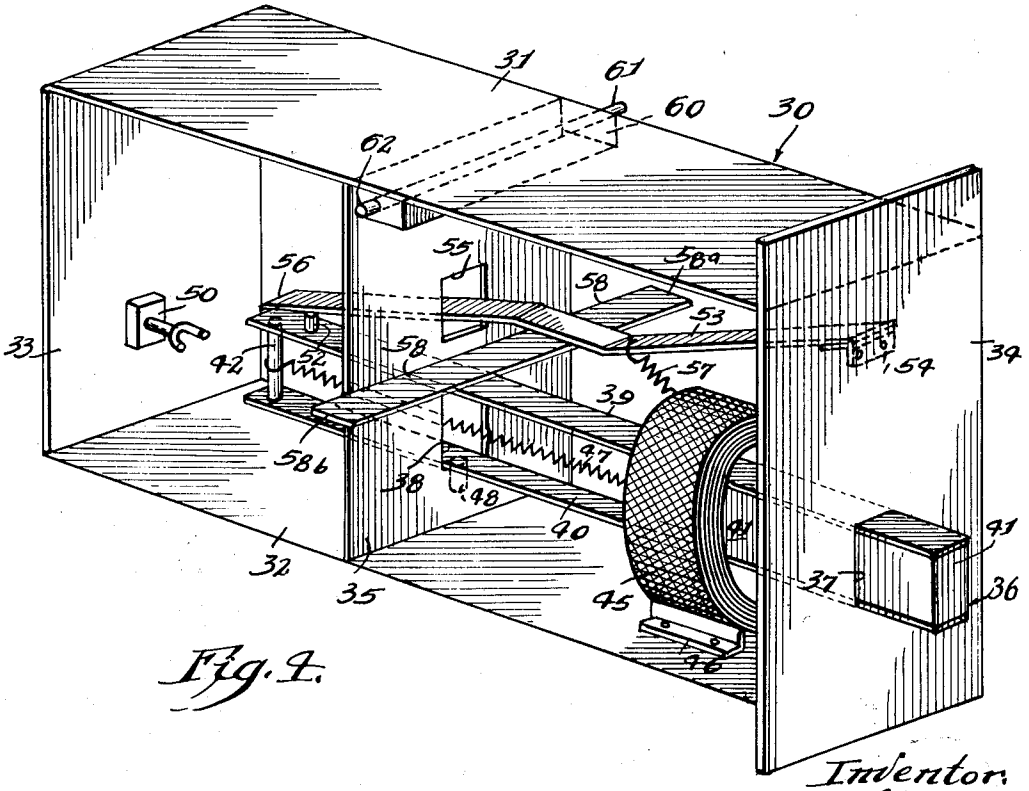


Fig. 4.

Inventor.
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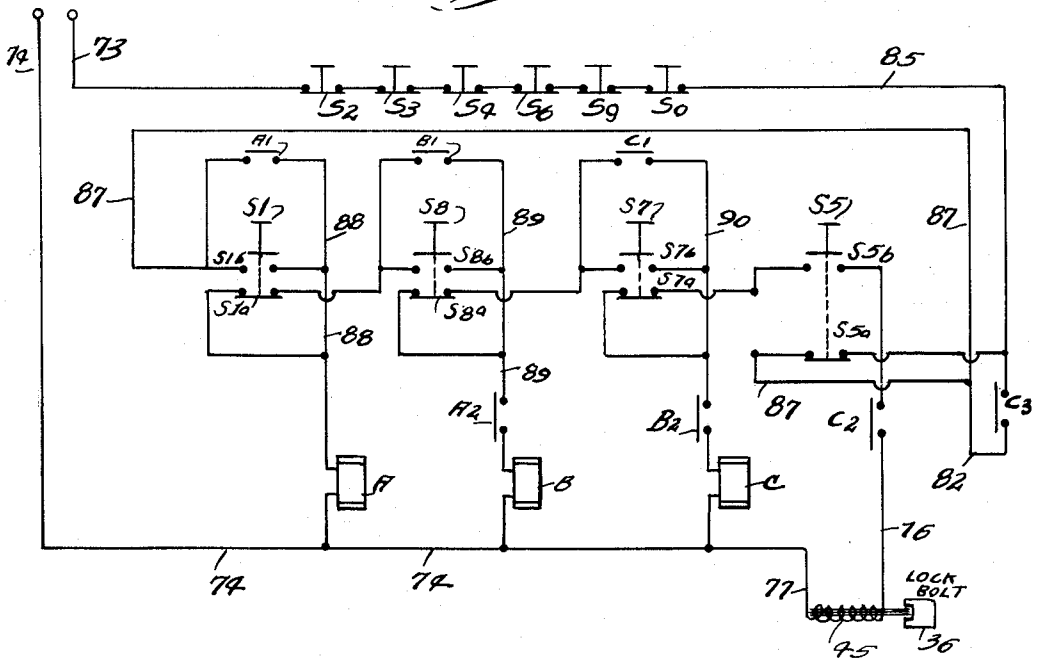
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Filed Feb. 6, 1961 2 Sheets-Sheet 2

Fig. 6.



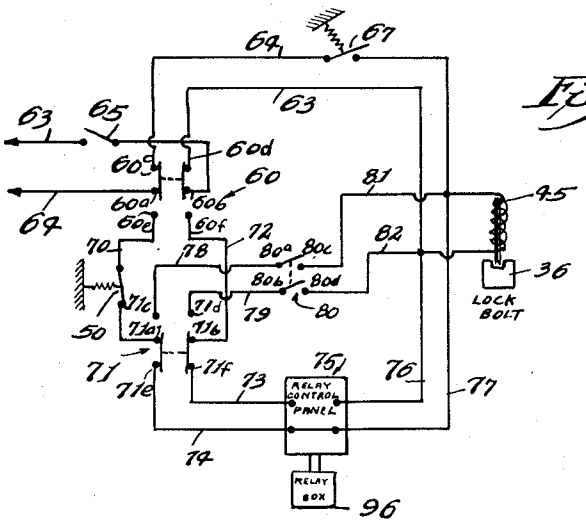


Fig. 5.

United States Patent Office 3,192,448 Patented June 29, 1965

3,192,448

KEYLESS ELECTRIC LOCK

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Filed Feb. 6, 1961, Ser. No. 87,162
4 Claims. (Cl. 317—134)

This invention relates to a control device and more particularly to an electrical control device for operating door locks or other mechanisms of the electromagnetic type.

An object of this invention is to provide a new and improved electric combination device, as for a door lock that requires actuation of each of a plurality of switches in a predetermined sequence.

Another object of this invention is to provide an electrically controlled device operable by a plurality of pushbuttons located on the outside of the door frame which engage an electrical control circuit to operate a lock mechanism when a preset series of the pushbuttons are successively pressed and released in a predetermined sequence, and which will fail to operate when any other sequence of the pushbuttons is actuated, or when a pushbutton is not released.

A further object of the invention is to provide a keyless electric lock having a control circuit energized by a series of relays, whereby each of the relays is operably associated with a switch having normally open and normally closed contact portions; and the first relay is operable directly by its associated switch, and each of the other relays in the series is operable through a contact controlled by the preceding relay, the normally closed contact of the preceding switch, and the switch associated therewith.

Another object is to provide such a control device having an operating member with an energizing circuit and a plurality of pushbuttons, whereby certain of said pushbuttons are operably associated with a plurality of successive switch means having normally open and normally closed contact portions, and the normally open contact portion of each successive switch means is connected in the energizing circuit through the normally closed contact portions of the preceding and succeeding switch means and the normally open contact portion of the last of the successive switch means connects the operating member to the energizing circuit.

Still another object is to provide such a device with an operating lock member mounted in a door frame to engage a keeper within the door whereby the member is operable by an electrical energizing circuit, and a switch is operated by the member to break the energizing circuit.

Another object is to provide a mechanical holding device to keep the operating member disengaged from the keeper when the energizing circuit is inoperable and a mechanical latch to release the holding device. Another object is to provide two energizing circuits for operating the latch, one of the circuits operable from the inside of the door and the other from the outside of the door.

Another object is to provide spring means to normally urge the operating member into engagement with the keeper.

Another object is to provide a simple and easy method for interchanging the operable association of the successive switch means with certain of the pushbuttons to vary the operational sequence of the control device.

Further objects and advantages will be apparent from the following specification and from the drawings, in which:

FIGURE 1 is an elevational view of a door having a lock device embodying the invention;

FIGURE 2 is an enlarged elevational view of an exposed keyboard panel on the outside of the door;

FIGURE 3 is an enlarged elevational view of an exposed panel on the inside of the door;

FIGURE 4 is a greatly enlarged perspective view of the mechanical operating mechanism of the lock device;

FIGURE 5 is a diagram of the electrical circuit incorporated in the lock device; and

FIGURE 6 is a schematic diagram of the pushbutton electrical circuit of the lock device.

Electrical combination devices that are now in use and operate a door latch by successive pressing of a preset combination of pushbuttons provide only limited security since, an operator, not knowing the correct operational sequence, may, by simultaneously pressing the pushbuttons, operate the device with a relatively few trial and error attempts. Applicant achieves a greater security than prior devices in a novel, and inexpensive manner by connecting the components of his device so that if any pushbutton is depressed other than the ones in proper sequence or if all the proper sequence buttons are depressed simultaneously, the combination circuit will fail to operate.

Referring to FIGURE 1, a door **10** having a knob **11** is mounted in a door frame **12** and an exposed panel or keyboard **13** is mounted on the outside of the door frame **12** containing a series of pushbuttons numbered **1, 2, 3, 4, 5, 6, 7, 8, 9, 0**, for operating the lock device. Mounted to the inside of the door frame, directly opposite panel **13** is a panel **15**, FIGURE 3. Various other switches and latch members are provided on panels **13** and **15**, the function of which will be described later.

FIGURE 4 shows the mechanical arrangement of the elements comprising an embodiment of the keyless electric lock device, which includes a rectangular housing **30** having a top plate **31**, a bottom plate **32**, a back plate **33** and a front plate **34**. An intermediate plate **35** is spaced between back plate **33** and front plate **34** to give additional support to housing **30**. The housing is mounted within a recess provided in the door frame **12** with the front plate **34** flush with the jamb of the frame. The housing is positioned between the panels **13** and **15** which are respectively mounted on the outside and inside of the frame and a communication is provided from the rear of the panels to the interior of the housing. The mechanism within the housing **30**, includes an elongated lock bolt **36**, longitudinally slidable within the housing **30** in guide slots **37** and **38** formed in the front plate **34** and the intermediate plate **35** respectively. The lock bolt **36** comprises two spaced elongated plates **39** and **40**. The front portion of the lock bolt **36** extends through the guide slot **37** and a bar **41** is provided between the plates **39** and **40** to maintain the spacing thereof, the bar extending from the front end of the lock bolt to a point generally midway the length thereof. The other end, or rear end, of the lock bolt **36** has a pin **42** between the plates **39** and **40** to maintain the spacing. An electromagnetic coil **45** is mounted by brackets **46** to the bottom plate **32** adjacent front plate **34** and completely surrounds the lock bolt **36**. A spring **47** is positioned between the plates **39** and **40** and has one end affixed to the rod **42** and the other end affixed to the frame of the solenoid **45** to normally urge the lock bolt **36** in a forward direction so that the front end thereof protrudes through the guide slot **37** and beyond the plate **34** to engage a keeper (not shown) in the door. A stop lug **48** is mounted on the underside of the plate **40** and extends downward engaging the rear surface of intermediate plate **35** to limit the forward movement of the lock bolt. When the lock bolt is in its retracted position, the length of the bar **41** should be such as to come in contact with a stop plate (not shown) located generally at the rear surface of the coil **45**.

The electromagnetic coil **45** may be energized by op-

erating buttons on panel 13 or panel 15 and such energization will retract the lock bolt 36 within the housing 30 so that its front end is substantially flush with the plate 34 thereby freeing the lock bolt from the keeper, and the door may be opened. When the lock bolt is fully retracted, the pin 42 engages a spring urged, normally closed, single pole, single throw switch 50 which is mounted on the inside surface of back plate 33 and upon such engagement breaks the electrical circuit to coil 45. The spring 47 would normally urge the lock bolt forward when the coil 45 is de-energized, but a holding device engages a lug 52 extending upward from the top surface of plate 39 adjacent the rear end thereof to prevent the forward movement of the lock bolt 36. The holding device consists of a bent elongated plate 53 having one end attached to the inside surface of the plate 34 adjacent the top plate 31 by a hinge 54. The elongated plate 53 extends longitudinally downward through an opening 55 in the intermediate plate 35 and has another end 56 terminating generally above the rear end of the plate 39 when the lock bolt 36 is in its extended or forward position. A spring 57 is connected to the plate 53 to the frame of the coil 45 to normally urge the plate 53 downward about its pivot at hinge 54.

When the lock bolt 36 is retracted by the energization of the coil 45 and moves rearwardly toward the switch 50, the lug 52 moves rearward to a point beyond the end 56 of the holding plate 53 before the switch 50 is contacted. The spring 57 urges the holding plate 53 downward to prevent the lock bolt from moving forward, after the coil is de-energized, by engagement of lug 52 with edge 56 of the holding plate. In order to release the holding device when it is desired to lock the door, a mechanical latch member consisting of a flat elongated bar 58 is positioned beneath the holding bar 53 and traverse its length. Ends 58*a* and 58*b* of the latch bar 58 extend outwardly beyond the sides of the housing 30 and protrude through the panel 13 and the panel 15 respectively for manual operation thereof from outside or inside the door. Raising either end of the latch bar 58 causes it to move upwardly against the underside of the holding bar 53 and raise the bar against the urging of spring 57 to disengage the end 56 from the lug 52 and allow the spring 47 to move the latch bolt forward to lock the door. Releasing the latch 58 drops it to its normal position below the holding bar 53 and the spring 57 positions the holding bar so that it is ready for subsequent use.

A double pole, double throw switch 60 is mounted to the underside of the top plate 31 directly above the latch bar 58 and has switch operating members 61 and 62 extending outwardly from the sides of the closure 30 and protruding from the panels 13 and 15, respectively.

Referring to FIGURE 5, a schematic of an electrical circuit for operating the keyless lock device is shown. The function of the electrical system is to supply power to the electromagnetic coil 45 by operating buttons on either the inside panel 15 or the outside panel 13. Power is provided from an external 110 volt alternating current source to the lines 63 and 64. The power lines 63 and 64 are connected through an off-on switch 65 that is mounted on the inside panel 15 to contacts 60*a* and 60*b* of the switch 60. The switch 60 is operable to each of its two positions by the buttons 61 on the outside panel 13 and the button 62 on the inside panel 15. When button 62 is depressed, a circuit is provided through points 60*a* and 60*c*, and 60*b* and 60*d* to connect the power lines 63 and 64 directly across the electromagnetic coil 45 through a single pole, single throw switch 67, that is mounted on the panel 15 and is spring-loaded in an open position. To operate the keyless electric lock device from the inside panel 15, assuming that the off-on power switch 65 is kept closed, the operator presses the button 62 to shift the switch 60 into the position shown in FIG. 5, and then operates switch 67 thereby energizing the coil 45 and drawing the lock bolt out of the keeper and into the housing 30 allowing the door to be opened. When the button 67 is released, the coil is de-energized, but the lock bolt remains in its retracted position due to the holding plate 53 engaging the lug 52, the operation of which has already been described.

In order to operate the latch device from the outside panel 13, assuming the power switch 65 is closed, the button 61 is depressed, shifting the switch 60 to its second position and making contact between the points 60*a* and 60*e*, and 60*b* and 60*f*. A line 70 connects the contact 60*e* through the normally closed switch 50 located on the plate 33 of housing 30 and to a contact 71*a* of a double pole, double throw, spring loaded, two-position switch 71 normally held in position shown in FIG. 5, which is located on the panel 13. A line 72 connects the contact 60*f* to a contact 71*b* of the switch 71. In the normal position the switch 71 provides a connection between contacts 71*a* and 71*e*, and 71*b* and 71*f*. A line 73 and a line 74 connect the contact points 71*f* and 71*e*, respectively, to a relay control panel 75, the operation of which will be described later. From the relay control panel, a line 76 and a line 77 are connected directly across the electromagnetic coil 45. The circuit through the coil 45 can be traced from line 64 through contacts 60*a* and 60*e*, line 70, normally closed switch 50, contacts 71*a* and 71*e*, line 74, relay control panel 75, line 77, coil 45, line 76, relay control panel 75, line 73, contacts 71*f* and 71*b*, line 72, contacts 60*f* and 60*b*, switch 65, and line 63. Operation of the lock member from the outside panel 13 requires the operator to push the button 61 shifting the switch 60, and successively operate other buttons on the panel 13 which are interconnected in the relay control panel, the operation of which will be later described. As mentioned before, when the lock bolt is retracted, the pin 42 engages the normally closed switch 50 which opens the circuit and deenergizes the coil 45. The holding device 53 again operates to keep the lock bolt retracted until it is desired to again lock the door by manual operation of the latch bar 58.

It has been mentioned that the switch 71, located on the outside panel 13 has two positions, one of which has already been described. The second position of the switch provides a connection between the contacts 71*a* and 71*c*, and the contacts 71*b* and 71*d*. A line 78 and a line 79 connect the contacts 71*c* and 71*d*, respectively, to contacts 80*a* and 80*b* of a normally open, single throw, double pole switch 80 mounted on the panel 13 and which is operated by insertion of a key thereby connecting the contact 80*a* with a contact 80*c*, and the contact 80*b* to a contact 80*d*. Lines 81 and 82 connect the contacts 80*c* and 80*d*, respectively, across the coil 45. It follows that with the switch 71 in the second position, the operator may insert a key in the switch 80 to supply power to the electromagnetic coil 45 and thereby bypass the relay control panel 75 to open the door without pressing the proper sequence of buttons on the relay control panel.

FIGURE 6 shows a schematic diagram of the relay control panel 75 which utilizes certain of the ten buttons located on the outside panel 13 to energize a series of relays A, B and C, to provide an energizing circuit for coil 45 and operate the lock mechanism from the outside of the door. In the described embodiment of the invention, a portion of the pushbuttons operate a plurality of successive switches each having a normally open and a normally closed contact, as a double pole, single throw switch, and the remaining pushbuttons operate a plurality of normally closed switches, as single pole, single throw switches. The circuit is arranged so the double pole, single throw switches are operated to energize the relays A, B and C when they are depressed and released in a certain predetermined sequence, and fail to energize the necessary relays if they are operated out of sequence. The single pole, single throw switches are incorporated to break the energizing circuit to any of the relays if they are opened by pressing their respective but-

tons. It should be pointed out that all of the switches located on the control panel **75** are interchangeable so they may be operated by any of the various pushbuttons on the panel **13**, providing a simple way to vary the sequence of buttons required to open the lock. The switches are accessible from the rear through a door **15***a* located on the panel **15** which is pivoted at the bottom by hinges **15***b* and which is secured in position by a conventional key lock **15***c*. For purposes of discussion, four double pole, single throw switches, S1, S8, S7 and S5 are provided and arranged so they are operable by pressing buttons **1**, **8**, **7** and **5** on the panel **13** and this sequence must be followed in order to energize the relays and open the lock.

Referring to FIGURE 6, the line **73**, which is the same line entering relay control panel **75** in FIGURE 5, is connected through a series of normally closed, single pole, single throw switches S2, S3, S4, S6, S9 and S0, to a line **85**. The switches are operated by correspondingly numbered buttons on the panel **13**. The line **85** is connected through a normally closed contact S5*a* of switch S5, to a line **87**. The line **87** is connected to a normally open contact S1*b* of switch S1. The first step in operating the combination of the relay control is to press and release the button **1** to close the normally open contact S1*b* and connect line **87** to a line **88**. Line **88** is connected to relay A and line **74** to energize the relay and close relay contacts A1 and A2. The line **87** is connected through the relay contact A1 to line **88** creating a holding circuit for relay A after the switch S1 has been released and contact S1*b* opened. Line **88** is also connected through the normally closed contacts S1*a* to the normally open contact S8*b* of switch S8. Button **8**, the next button on the combination sequence, is now depressed, and released, closing the normally open contact S8*b* and connecting line **88** to a line **89**. Line **89** is connected through the now closed contact A2 to the relay B, and line **74**, to energize relay B and close relay contacts B1 and B2. A holding circuit for relay B is provided through the relay contact B1 after button **8** has been released in the same manner as for relay A. A circuit is now provided from line **89** through the now closed contact S8*a* to a normally open contact S7*b* of the switch S7. The switch S7 is operated by depressing and releasing the button **7**, the next button in the sequence combination, to close the contact S7*b* and connect the line **89** to a line **90**, and through the closed contact B2 to energize relay C, closing contacts C1, C2 and C3. A holding circuit is also provided for relay C through closed relay contact C1. When the switch S7 has been released, a circuit is provided to the normally open contact S5*b* of the switch S5 from line **90**, through the now closed contact S7*a*. Depressing button **5**, which is the last button in the sequence combination, will close the normally open contact S5*b*, and open the normally closed contact S5*a*. A circuit is then provided from the line **90** through the contacts S5*b*, and closed relay contact C2, through the electromagnetic coil **45** and line **77** to line **74**, energizing the coil and operating the lock bolt **36**. When the button **5** is depressed to operate the switch S5, the circuit energizing the coil **45** may be traced as follows: line **73**, S2, S3, S4, S6, S9, S0, line **85**, closed relay contact C3, line **87**, closed relay contact A1, line **88**, normally closed switch contact S1*a*, closed relay contact B1, line **89**, normally closed switch contact S8*a*, closed relay contact C1, line **90**, normally closed switch contact S7*a*, contact S5*b*, closed relay contact C2, line **76**, coil **45**, line **77**, and line **74**.

From the foregoing discussion, it is seen that the switch S1 must be depressed and released in order to provide a circuit through the normally closed contact S1*a* to energize the relay coil B when the switch S8 is depressed. The same is true of switch S8 which must be released in order that a circuit through the normally closed contact S8*a* is available to energize the relay coil C when the switch S7 is depressed. S7 must also be released to complete a circuit through S7*a* in order that the switch S5 will be effective to energize the coil **45**. Therefore, each switch in the sequence combination must be depressed and released in a predetermined order in order to energize the relay coils and supply voltage across the electromagnetic coil **45** to operate the lock bolt.

It should be noted that it is not necessary to release the last switch in the series, in this case S5, to supply voltage across the coil **45**. Also when the switch S5 is depressed, the normally closed contact S5*a* is opened, breaking the circuit from line **85** to line **87**. However, the circuit is maintained through the relay contact C3 which is held closed by the energized relay C. From the foregoing, it can be seen that if any of the switches are operated out of their proper predetermined sequence, the flow of current through the circuit will be interrupted, and if all of the buttons in the sequence are pressed simultaneously, no relays will be energized since the last switch in the series must operate either to supply voltage across the coil **45** or to break the connection from line **85** to line **87**.

It should also be noted that if any of the switches S2, S3, S4, S6, S9, or S0 are depressed, the circuit from line **73** to line **85** will be broken and de-energize any relay that may have been energized.

While actuation of a predetermined sequence of four switches is required in the described embodiment of the invention, it is to be understood that a sequence of n successive switches, having normally open and normally closed contact portions, may be incorporated with a relay associated with each of the initial $n-1$ switches in order to increase the security of the lock device. The normally open contact portions of the successive switch means are connected in the energizing circuit through the normally closed contact portions of preceding switch means and the succeeding last $n-2$ switch means. Thus any out-of-order actuation of the switches fails to complete the circuit. Because of the unique circuit arrangement, the mathematical chance of opening the door without knowing the predetermined sequence combination has been greatly increased over known systems using the same number of code switches, resulting in a substantial security factor for the subject lock. Extending the number of switches in the circuit greatly increases the mathematical odds against breaking the combination.

The illustrated embodiment of the invention provides for a predetermined sequence of four buttons, of a group of 10, that are depressed and released to open the lock. Switches operated by the buttons are connected so that the lock control will not operate whenever a button is depressed out of its predetermined order, or if any button is depressed other than the ones in the sequence, or if all the buttons in the sequence are depressed at one time. The mathematical chance of breaking the code of applicant's device and opening the lock by trial and error when using sequences of different numbers of buttons is as follows:

1 button, 1 chance in 10
2 buttons (9×10), 1 chance in 90
3 buttons ($8\times9\times10$), 1 chance in 720
4 buttons ($7\times8\times9\times10$), 1 chance in 5,040
5 buttons ($6\times7\times7\times9\times10$), 1 chance in 30,240

Other known systems can be operated by depressing all of the buttons of a sequence simultaneously which would give the following mathematical chance of breaking the code, with sequences of different numbers in a group of ten buttons:

1 button, 1 chance in 10
2 buttons, 1 chance in 45
3 buttons, 1 chance in 120
4 buttons, 1 chance in 210
5 buttons, 1 chance in 252

By comparing the two systems it can be seen that applicant's device provides a substantial increase in security.

Referring back to FIGURE 3, a slot **95** is provided in the lower corner of door **15***a* for receiving a screwdriver or other instrument to manually retract the lock bolt **36** in the event of a power failure and when the key for lock **15***c* is not available.

The relays A, B and C that are associated with the successive switches S1, S8 and S7 are located on a relay box **96** remote from the control panel so that anyone attempting not knowing the proper sequence would be unable to hear the operation of the relays and easily break the code.

While I have shown and described embodiments of my invention, it is to be understood that it is capable of many modifications. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as disclosed in the appended claims.

I claim:

1. An electrical combination control for a lock having an operating member connectable with an energizing circuit, comprising: means providing a source of electrical energy to which said energizing circuit is connected; a plurality of buttons mounted on a keyboard; a plurality of normally closed switches connected in said energizing circuit and operably associated with certain of said buttons, to be opened upon actuation of the associated buttons; a plurality of switch means operably associated with others of said buttons for successive operation to connect said operating member with said source, and having normally open and normally closed contact portions, the normally closed contact portions being connected in series in said energizing circuit; a plurality of relays each connected through the normally open contact portion of at least a portion of said switch means, across said source, and each having a holding contact connected in parallel with said normally open contact portion of the associated switch, the normally open contact portions of successive switch means being connected in said energizing circuit through the normally closed contact portions of the preceding successively operated switch means; and a normally open contact associated with the last of said successive switch means, for connecting said operating member with said energizing circuit.

2. An electrical combination control for a lock having an operating member with an energizing circuit, comprising: means providing a source of electrical energy to which said energizing circuit is connected; a plurality of buttons mounted on a keyboard; a plurality of normally closed switches connected in series in said energizing circuit and operably associated with certain of said buttons; a plurality of successive switch means operably associated with others of said buttons for successive operation to connect said operating member with said source, and having normally open and normally closed contact portions, the normally closed contact portions being connected in series in said energizing circuit; a relay connected through the normally open contact portion of at least a portion of said switch means, across said source, and each having a holding contact, the normally open contact portions of successive switch means being connected in said energizing circuit through the normally closed contact portions of the preceding and succeeding switch means; and a normally open contact associated with the last of said successive switch means, for connecting said operating member with said energizing circuit.

3. An electrical combination control for a lock having an operating member with an energizing circuit, comprising: means for providing a source of electrical energy to which said energizing circuit is connected; a plurality of buttons mounted on a keyboard; a plurality of normally closed switches in said energizing circuit and operably associated with certain of said buttons, to be opened upon actuation of the associated buttons; *n* switch means operably associated with others of said buttons for successive operation to connect said operating member with said source and having normally open and normally closed contact portions, the normally closed contact portions being connected in series in said energizing circuit; a relay for each of the initial *n*—1 switch means, each relay being connected through the normally open contact portion of the associated switch means, across said source, and having a holding contact connected in parallel with said normally open contact portion, the normally open contact portions of successive switch means being connected in said energizing circuit through the normally closed contact portions of the preceding switch means and of the succeeding switch means; and a normally open contact associated with the last of said successive switch means for connecting said operating member with said energizing circuit.

4. A combination electrical control system comprising: a series of successive switch means, having normally open and normally closed contact portions; a series of electromagnetic relays, each of said relays having an operating coil and contacts connected in a circuit with one of said normally open contact portions, the first of said relays being operable directly by its associated switch, and each of the other relays in the series being operable through a relay contact controlled by the preceding relay, the normally closed contact portion of the preceding switch, and the associated switch thereof; and a holding circuit for each relay to maintain said relay energized after its operation, the holding circuits including said normally closed contact portions of the preceding switch means, the holding circuit of each of the relays being broken when any of the switches is operated out of the series order.

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ALBERT H. KAMPE, DONLEY J. STOCKING, *Examiners.*